EXPRESS MAIL LABEL NO.

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METHOD AND APPARATUS FOR POLISHING A WORKPIECE

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Background of the Invention

[0001] This invention pertains to a method and apparatus for polishing a workpiece.

[0002] A typical process for manufacturing a magnetic disk comprises the following:

1. An Al alloy substrate having an ID and an OD is provided.
2. The edges at the ID and OD of the substrate are chamfered.
3. The substrate is electroless plated with a NiP.
4. The NiP is polished. (See, for example, U.S. Patent 6,149,696, issued to Jia, incorporated herein by reference.)
5. The NiP is textured. (See, for example, U.S. Patent Application 10/299,028, filed by Homola, incorporated herein by reference.)
6. One or more underlayers (e.g. Cr or a Cr alloy) are sputtered onto the textured NiP.
7. One or more magnetic layers (e.g. Co magnetic alloys) are sputtered onto the underlayers.

8. One or more protective layers (e.g. C or hydrogenated C) are deposited onto the magnetic layers. (See, for example, U.S. Patent 6,565,719, issued to Lairson et al., incorporated herein by reference.)

(Other layers, e.g. Ru intermediate layers, seed layers, and other types of layers are sometimes deposited at different points during the manufacturing process. See, for example, U.S. Patent Application 10/075,123, filed by Bertero et al., incorporated herein by reference.)

[0003] As described by Jia, substrates are often polished in planetary polishing apparatus. Figs. 1A and 1B schematically illustrate in plan view and cross section, respectively, polishing apparatus 1 constructed in accordance with the prior art. Such apparatus comprises a substrate holder 2 having openings 3 for accommodating substrates 4 that are to be polished. (Substrates 4 have a centrally defined opening 4c therein.) Holder 2 is roughly circular, and comprises teeth 5 for engaging with a central "sun gear" 6 and for engaging with an outer gear 7. Gears 6 and 7 cause holder 2 to revolve around sun gear 6 (see arrow A) while simultaneously rotating about the center 8 of holder 2 (see arrow B). Upper and lower pads 9, 10 (mounted on rigid platens 11, 12 respectively) press against the upper and lower surfaces 4a, 4b of substrates 4. Slurry is provided between pads 9, 10 and substrates 4 to polish substrates 4.

[0004] At the conclusion of polishing, it would be desirable for the substrate 4 to have a profile as shown in cross section in Fig. 2. Unfortunately, substrates often emerge from the polishing process with a defect called "roll-off", schematically shown by dotted lines R in Fig. 3, which extends into the data zone 4z. (Data zone 4z is where data will ultimately be recorded on the disk when it is finished.) One cause of roll-off is that

substrates 4 have a thickness T4 that is greater than thickness T2 of carrier 2. Therefore, pads 9, 10 tend to push harder against the edges E of substrates 4, thereby causing roll-off. It would be desirable to prevent roll-off.

Summary

[0005] Apparatus in accordance with the invention comprises a carrier for holding a workpiece being polished. The workpiece is typically disk-shaped or circular. A ring is provided between the carrier and the workpiece. During use, the workpiece is held within the carrier, and one or both sides of the workpiece move against a polishing pad to polish the workpiece. In one embodiment, planetary polishing apparatus is used during polishing, and slurry is introduced between the polishing pad and the workpiece. (In such an embodiment, first and second polishing pads are urged against first and second sides of the workpiece, respectively, during polishing.) The ring is substantially as thick as or thicker than the workpiece, and prevents "roll-off" in the workpiece at the outer edge of the workpiece.

[0006] In one embodiment, the ring is not rigidly affixed to the carrier, and therefore can rotate during use. Also, in one embodiment, the ring has a gap in it. As explained below, in one embodiment this gap a) makes it easier to meet manufacturing tolerances when making the ring so that it fits into the carrier; and b) facilitates rotation of the ring and workpiece within the carrier during use for more even and uniform polishing. The ring can be manufactured by cutting sections of a spring.

[0007] A method in accordance with the invention comprises placing a workpiece and a ring within a carrier, and causing at least one polishing pad to move with

respect to the workpiece to thereby polish at least one surface of the workpiece. As mentioned above, planetary polishing apparatus can be used during this method. The ring can rotate within the carrier, and the workpiece can rotate within the ring during polishing. The ring contains a gap. In one embodiment, this gap a) makes it easier to meet manufacturing tolerances when making the ring so that it fits into the carrier; and b) facilitates rotation of the ring and workpiece within the carrier during use.

Brief Description of the Drawings

[0008] Figs. 1A and 1B illustrate in plan view and cross section, respectively, planetary polishing apparatus constructed in accordance with the prior art.

[0009] Fig. 2 illustrates in cross section a desired profile of a substrate

[0010] Fig. 3 illustrates in cross section a substrate having "roll-off".

[0011] Fig. 4A and 4B illustrate in plan view and cross section, respectively, polishing apparatus constructed in accordance with a first embodiment of the present invention.

[0012] Fig. 5A and 5B illustrate in plan view and cross section, respectively, polishing apparatus constructed in accordance with a second embodiment of the present invention.

[0013] Fig. 6A and 6B illustrate in plan view and cross section, respectively, polishing apparatus constructed in accordance with a third embodiment of the present invention.

[0014] The figures are not drawn to scale.

Detailed Description

[0015] Referring to Figs. 4A and 4B, a holder 20 comprises openings 22 for holding disk-shaped workpieces 24. In one embodiment, workpieces 24 are substrates used for manufacturing magnetic disks, and can comprise an Al alloy electroless plated with a NiP alloy. However, workpieces 24 can be other types of workpieces as well. Holder 20 can be used in conjunction with planetary polishing apparatus such as model no. 9B14, manufactured by Speedfam International Corp. of Des Plaines, Illinois. However, other types of polishing apparatus can also be used, e.g. single disk polishers and ring polishers.

[0016] Polishing pads 9, 10 push against upper and lower surfaces 24a, 24b, respectively, of workpieces 24. Pads 9, 10 can be device model no. CR200, manufactured by Kanebo, or device model no. FK1, manufactured by Fujibo (located in Japan). However, other types of pads can also be used. Pads 9, 10 are affixed to rigid platens 11, 12, respectively, which urge pads 9, 10 against workpieces 24. One or more openings (not shown) can be provided in platens 11, 12 and/or pads 9, 10 to permit introduction of slurry between the pads and workpieces during polishing.

[0017] In one embodiment, workpieces 24 have a diameter D24 of 95 mm and a thickness T24 of 1.27 mm. However, these dimensions are merely exemplary. Holder 20 can be fiberglass or an aramid material. Holder 20 is preferably thinner than workpieces 24 (e.g. having a thickness T20 between 0.8 and 1.2 mm, and preferably 1.0 mm) to avoid pushing against and scraping slurry off of polishing pads 9, 10. The material and dimensions of holder 20 are merely exemplary.

[0018] Within openings 22 are rings 26 which surround workpieces 24. Rings 26 are generally not rigidly affixed to holder 20, and thus it is typically possible for rings 26 to rotate within openings 22. (It is also typically possible for workpieces 24 to rotate within rings 26.) Rings 26 have a thickness T26 (Fig. 4B) that is greater than thickness T24, and typically greater than T26 plus 2 μm. In one embodiment, T26 minus T24 is between about 2 and 100 μm, e.g. 20 μm. These numbers are exemplary, but it is generally desirable that T26 be greater than T24 to minimize or avoid roll-off. Also, in one embodiment, rings 26 have a width W26 of about 1.5 mm, but this is also exemplary. Fig. 4A also shows an optional chamfer 25 at the OD of workpiece 24. Chamfer 25 is preferably a 45° chamfer, although other angles (e.g. 30°) can be used. (Optionally, chamfers can also be present at the ID of workpieces 24.) The flat upper and lower surfaces of workpiece 24 are typically a distance D32 of 0.122 mm from ring 26.

[0019] In one embodiment, the hardness of the material from which rings 26 is manufactured is greater than or equal to the hardness of workpiece 24. As mentioned above, in one embodiment, workpiece 24 comprises a NiP-coated substrate. In such an embodiment, rings 26 can also be made from NiP (or a material coated with NiP).

[0020] Rings 26 have gaps 26g therein. In one embodiment, the gaps have a width between 0 and 5 mm (preferably closer to 0 mm than 5 mm). Gaps 26g provide the following advantages.

1. It is easier to manufacture rings 26 because it is unnecessary for rings 26 to have an outer diameter exactly equal to the inner diameter of openings 22. If the diameter of a ring 26 is too great to fit into an opening 22, one can pull ends 26a, 26b of ring 26 (Fig. 4A) closer together so that ring 26 fits into opening 22. Similarly, if the diameter of ring

26 is too small to permit insertion of workpiece 24, ends 26a, 26b can be pulled apart so that ring 26 can accommodate placement of workpiece 24 therein.

2. Because of gap 26g, it is easier to ensure that ring 26 can rotate within opening 22 (relative to carrier 20) and that workpiece 24 can rotate within ring 26. This has the advantage of permitting more even and uniform polishing.

[0021] From the foregoing it is seen that there is a discontinuity in ring 26 between ends 26a and 26b. As used herein, the term "discontinuity" encompasses a gap such as gap 26g. The term "discontinuity" also encompasses a situation in which end 26a is flush against end 26b, as may happen from time to time because of manufacturing tolerances during the manufacture of workpiece 24, ring 26 and/or holder 20.

[0022] Referring to Figs. 5A and 5B, in a second embodiment of the invention, a ring 32 is inserted into the ID of workpiece 24 to prevent roll-off at the ID. (Workpiece 24 shown in Fig. 5B comprises a chamfer 33 at its ID.) Ring 32 is made from a material similar to or the same as that used to manufacture ring 26. In other words, ring 32 is typically as hard as or harder than the material used to make workpiece 24. Ring 32 preferably has a gap 32g therein (although in other embodiments, gap 32g is not provided in ring 32). Also, ring 32 has a thickness similar to or the same as that of ring 26. Thus, the thickness T32 of ring 32 is typically about as great as or greater than the thickness T24 of workpiece 24. (It should be noted that the invention can be practiced using ring 32 without ring 26 present, or using ring 26 without ring 32 present, e.g. if one is only concerned with preventing roll-off at just the ID or just the OD.)

[0023] Referring to Figs. 6A and 6B, in a third embodiment of the invention, a disk 36 is inserted into the central opening of workpiece 24. Disk 36 is made of a

material similar to or the same as that used to manufacture ring 26. In other words, the hardness of disk 36 is typically equal to or greater than that of workpiece 24. Preferably has a thickness similar to or the same as that of ring 26. Thus, thickness T36 of disk 36 is typically approximately equal to or greater than thickness T24 of workpiece 24. In this embodiment, disk 36 prevents roll-off at the ID of workpiece 24. (It should be noted that the invention can be practiced using disk 36 without ring 26 present, or using ring 26 without disk 36 present, e.g. if one is only concerned with preventing roll-off at just the ID or just the OD.)

[0024] As mentioned above, typical magnetic disk substrates comprise an Al alloy plated with a NiP alloy. However, the present invention can be used in conjunction with other types of layers deposited on a substrate, e.g. a soft magnetic layer of the type used to manufacture perpendicular recording magnetic disks. In addition, the invention can be used in conjunction with the polishing of other types of substrates, e.g. glass, glass ceramic, ceramic, carbon, and metals such as Ti or Ti alloys. It is desirable to polish such materials, and prevent roll-off therein. Such substrates can be used to manufacture magnetic disks. In addition, the present invention can be used in conjunction with the polishing of semiconductor wafers during integrated circuit manufacturing (e.g. silicon, gallium arsenide or other semiconductor materials).

[0025] While the invention has been described with respect to specific embodiments, those skilled in the art will recognize that changes can be made in form and detail without departing from the spirit and scope of the invention. For example, different types of workpieces can be used in conjunction with the invention. Different types of polishing apparatus can be used (e.g. planetary polishers, ring polishers, single

disk polishers, polishers that polish only one side of a workpiece at a time or polishers that polish both sides of a workpiece at a time). A holder used in conjunction with the invention can have one or more openings. Accordingly, all such changes come within the invention.